

The Process of Building Faculty Buy-in for Course-based Adaptations of an Ecological Belonging Intervention to Transform Engineering Representation at Scale

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The Process of Building Faculty Buy-in for Course-based Adaptations of an Ecological Belonging Intervention to Transform Engineering Representation at Scale

Abstract

Despite decades of effort by institutions and faculty to provide students with equal access to educational opportunities and success in engineering, equity gaps in outcomes for women and for Black, Latinx and Indigenous students remain. The ecological belonging intervention we are scaling through a collaborative effort at the University of Pittsburgh, Purdue University, and the University of California, Irvine has been shown to erase long-standing equity gaps in student outcomes in introductory STEM courses and requires only one class or discussion/recitation session to implement. Instructors play a key role in the student experience, and their perspectives on diversity, equity, and inclusion may contribute to their willingness to implement this intervention within their courses. This work investigates both student-level and instructor-level issues, specifically: 1) the ways in which a brief ecological belonging intervention should be customized for different course contexts; 2) the key mechanisms underpinning how the intervention supports proximal and distal student outcomes; and 3) the efficacy and mechanisms by which course onboarding strategies involving leadership messaging and community learning processes are successful across varied course, departmental, and university contexts in transforming each targeted course.

In this paper, we focus on the third component and describe our process for building buy-in with leadership and faculty regarding this intervention. As a part of this process, we have gathered survey information to understand instructor willingness to use this intervention in their classroom including instructor attitudes about diversity, equity, and inclusion; barriers for implementation; and other concerns. One of the goals is to identify differences between faculty who would be willing to take action to address these equity issues through implementing the ecological belonging intervention and those who would not be willing to do so. We will also provide an update on the results of the intervention on student outcomes. Our findings can help inform strategies for institutional scaling and transformation and potential barriers for others interested in the uptake of evidence-based classroom engineering education efforts.

Introduction

Supported by a *NSF IUSE: EDU Program, Institutional and Community Transformation track* grant (NSF IUSE 211114/2111513), this collaborative project at the University of Pittsburgh, Purdue University and the University of California, Irvine entitled “Collaborative Research: Strategic Course-based Adaptations of an Ecological Belonging Intervention to Broaden Participation in Engineering at Scale” uses a brief ecological intervention that only requires one

class or recitation/discussion session to implement and that has been shown to erase long-standing racial equity gaps in academic achievement in introductory STEM courses [1]. With the success of contextualizing and running the ecological belonging intervention at our campuses and testing it at one institution in the first year of the grant project, our focus in the second year has turned to building buy-in for widespread uptake of this intervention effort with faculty to promote institutional transformation.

Despite decades of explicit effort by institutions and faculty to provide Black, Latinx, and Indigenous (BLI) students in STEM with equitable access to educational opportunities and success, considerable gaps in achievement remain [2], [3]. Black and Latinx students have been shown to have higher interest than their White peers in STEM majors, including in engineering [4]–[6], yet despite this strong interest, they are less likely than their White peers to enroll or persist in the degree path. One factor that has been shown to help lessen this gap in student representation is positive interaction with faculty [7]–[10]. Positive faculty interaction promotes behavioral and emotional engagement in engineering [11] while contrarily, unwelcoming classroom or campus environments for minoritized students in STEM have been shown to negatively affect performance [1] and contribute to students' decisions to leave the engineering [12] as well as other STEM majors [13]. Faculty have a key role in shaping classroom norms which have a significant impact on student outcomes [14] and through our intervention, faculty have the opportunity to implement a practice that signals not only their support for BLI students, but also promotes an environment that encourages persistence, improves GPA, and enhances sense of belonging [1]. The Boyer Commission report, titled *A 2030 Blueprint for Undergraduate Education at U.S. Research Universities* [15], emphasizes the importance of “intentional development of supportive, equitable learning environments” for strengthening BLI undergraduate students' sense of belonging. Our intervention is aimed at facilitating the creation of these spaces at the institutions in our study, but the process of creating these spaces takes commitment by faculty and administrative leaders to enhance their classroom spaces and the larger engineering community in ways that further support students.

There are numerous barriers to developing faculty investment in implementing new evidence-based practices in their classrooms, including the amount of time needed to learn and then to implement the practice, concerns about student feedback, impacts on promotion and tenure review, concerns about the likelihood of successful implementation, lack of knowledge regarding effective support strategies, lack of funding, and the need for support from administrators and peers [16]. To begin to address these barriers, we focused on building support broadly for reasoned action. In beginning our work on, we posit that change occurs when there is a high perceived need for change and perceived ease of implementation, both of which are influenced by social norms [17], [18].

We demonstrated the high perceived need for change through creating relationships with administrative leaders who underscored the importance of this work on their campus. Support from campus leaders is a central component of transformational leadership [1], [19], [20]. The leaders,

or “course champions,” assisted our team by making the implementation process as simple as possible for faculty members. Making these connections and subsequently allowing faculty to voluntarily opt into the proposed intervention has been shown to partially alleviate the resistance to top-down change [21], [22]. Our onboarding process is designed to empower faculty to take ownership of the intervention within their classroom context, rather than enacting a practice they do not support or fully understand. We anticipate that faculty who perform the intervention and administrators who support it will utilize the efforts toward institutional transformation they begin through the implementation of the intervention as a catalyst to initiate broader equity-focused change.

Project Description

Our project builds on prior social-belonging interventions [23], [24] by adapting the intervention to different engineering classroom contexts and training instructors to deliver the intervention as part of a social “ice-breaker” activity at the beginning of the term [1]. In this study we examine how the intervention can be translated to different institutional contexts, scaled for widespread impact, and how faculty engage in, influence, and are influenced by administering the intervention in their courses. This project has three university partners: University of Pittsburgh (Pitt), Purdue University, and University of California, Irvine (UCI). Scaling across these institutions allows us to explore the effects of differences in race/ethnicity in the undergraduate student body, institutional size, and cultural norms (see [25] for a fuller description of the participating institutions).

The Ecological Belonging Intervention (Base Form)

Here we describe the base form of the in-class intervention that has closed demographic performance disparities in prior research [1], [20]. As noted, the intervention was developed from prior social belonging interventions [26], which taught students that adversity in college is both normal and surmountable. The ecological approach attempts to instill the same message, not just within individual students, but within the social ecology of the classroom. Namely, rather than being delivered in a lab setting as in prior work, the ecological-approach targets carefully selected populations—classrooms with specific, known demographic disparities in performance. The intervention is adapted to these classrooms via focus groups. Rather than being delivered by an experimenter, course instructors or TAs are trained to deliver the intervention and to engage their students in peer discussion around it. These peers are not random strangers but rather classmates with whom they will work together over the term. The intervention is delivered early in the term, during the first or second week of classes.

The intervention (described in more detail in [1] and as adapted to engineering for this project in [25]) was designed to establish a classroom norm that a) adversity in the course is common and normal and b) these struggles tend to be temporary and surmountable with time and effort. It does so with five parts, delivered in the following order:

- 1) The instructor verbalizes the normalcy and surmountability of adversity in college and in the course more specifically.
- 2) Students are asked to complete a writing exercise in which they reflect on the challenges they have already experienced in college and how those challenges might change with time.
- 3) Students are then presented with stories written in the first-person and attributed to more senior students. These stories are tailored to the classroom environment following focus group input from prior students in the course. The stories convey a narrative that while students commonly encounter initial doubts and uncertainty in the course (e.g., having a hard understanding certain concepts), they persisted and overcame these challenges by, for example, reaching out to the TA for help, collaborating with classmates, or changing the way they appraised their adversity.
- 4) Students then engage in semi-structured small-group discussion that is designed to establish the intersubjective validity of the intervention message. For example, we ask students to discuss why so many students do not like to admit they are struggling with certain concepts in the course. By speaking and hearing answers to these prompts, we engaged both “saying is believing” [27] and social proof [28] as methods to establish the intervention message as a classroom norm.
- 5) Finally, the instructor brings the full class back together and asks volunteers to share what their group has discussed.

Research Questions

Research on the Intervention’s Effects on Students

The first part of our research plan focuses on understanding how the ecological belonging intervention that was initially developed for first-year courses translates into second-year courses and how it can be adapted across institutional contexts in both first- and second-year engineering courses. We pose three research questions:

RQ1 (the course contexts): How do students, with a focus on minoritized students (i.e., Black, Latinx, and Indigenous, women and non-binary students), describe their lived experiences in courses that show demographic-based achievement differences?

RQ2 (the immediate effects on students): How does the ecological belonging intervention change students’ feelings of belonging in the course, their disciplinary-based growth mindset, and perceptions of academic norms in the course, major, and engineering overall?

RQ3 (the broader effects on students): What effect does the intervention have on short- and long-term academic success as measured by achievement (course-specific, overall GPA) and choice (retention, engineering career pathways)?

Research on the Scaling and Transformation Approach

The second aspect of the project is designed to understand the efficacy and mechanisms by which course onboarding strategies involving leadership messaging and community learning processes are or are not associated with promoting course transformation across various contexts. Without broad and sustainable adoption, no meaningful overall change will occur in the representation of minoritized students in engineering pathways that have been historically resistant to change. In addition, we examine whether implementing the intervention influences instructor beliefs: there is extensive research showing that attitudes tend to change after behaviors change [29], [30]. Changes in instructor beliefs have the potential for positively changing other courses they teach, clubs they advise, and students they mentor. In particular, our scaling and institutional transformation research questions are:

RQ4 (context effects on onboarding strategies): What are the key disciplinary and institutional factors that demand adaptation to the onboarding strategies?

RQ5 (impact of onboarding strategies on instructor beliefs): What are the effects of the onboarding strategies on instructor beliefs that are key to intervention implementation?

RQ6 (impact of instructor beliefs on intervention implementation): What are the instructor beliefs most critical to implementation (initial and sustaining implementation) of the intervention?

RQ7 (impact of implementation on instructors): What impact does implementing the intervention have on instructors' mindsets, attitudes, and practices?

In the first year of the grant, an analysis of institutional data for one participating institution in engineering revealed a consistent equity gap in student academic performance in a first-year engineering course by race and ethnicity when controlling for gender, international student status, first-generation college student status, term, and instructor of ~ 0.44 on a 4.0 Grade Point Average (GPA) scale [31]. We describe these disparate impacts in a given course as *equity gaps* because they exist not from any deficit of the students themselves but rather from systemic issues of marginalization that make students feel as if they do not belong. Due to GPA cutoffs for matriculation into various disciplines, these equity gaps can have significant impacts on student entry into their major of choice during their second year of study at this institution.

Our preliminary results [RQ2] from implementing the ecological belonging intervention in Spring 2022 indicate that the intervention was effective in reducing belonging losses for BLI students within this first-year engineering course as measured by a pre-semester and post-semester survey. Belonging was measured using a three-item construct ($\alpha = .82$). The items asked participants to agree or disagree with statements about their sense of belonging, ability to be themselves, and feelings of acceptance within their class. Participants who identified as Black/African American, American Indian, Mexican, Central American, Puerto Rican, Other Latino/a/x, and Native Hawaiian/Pacific Islander were grouped into a larger category (BLI, $n = 88$) for comparison with the majority group of White and Asian students ($n = 737$). Although we would have preferred to model belonging separately for each BLI group, we lacked the statistical power to proceed in this direction and made the decision to group these students together within the analysis [32].

Six sections of the course participated in the study; three in a “business as usual” condition (i.e., control; $n = 331$) and three who received the ecological belonging intervention ($n = 360$). Of those students, 825 completed pre- or post-surveys for a 60% completion rate. All student groups began the semester with average belonging scores above 3.0 on a 5.0 scale. White and Asian students in the control condition had consistent scores on the pre-survey ($M = 3.12$, $SD = .39$) and post-survey ($M = 3.11$, $SD = .44$), while BLI students in the control condition reported a decrease in belonging between the beginning of the semester ($M = 3.31$, $SD = .50$) and the end of the semester ($M = 2.90$, $SD = .90$). Majority students in the treatment condition reported slightly lower belonging from pre ($M = 3.17$, $SD = .49$) to post ($M = 3.05$, $SD = .52$), while BLI student scores increased slightly from pre ($M = 3.10$, $SD = .44$) to post ($M = 3.14$, $SD = .46$).

The intervention also addressed performance equity gaps on individual assignments in the course but did not fully close the gap on overall course performance [RQ3]. On average, BLI students in the intervention condition had an individual grade percentage ($M = .89$, $SE = .05$), which was .22 points higher than BLI students in the control condition ($M = .67$, $SE = .05$). We hypothesize that the buffering effect of the intervention directly resulted in these results and our current work includes a larger implementation of the intervention at this institution (described in the section below) as well as at our other partnering institutions.

Building Institutional and Faculty Partners

A central tenet of the UBelong Collaborative that we address in RQs 4 - 7 is the development of faculty change agents and the transformation of the culture and processes in the institutions where they work and teach [33]. We began by recruiting faculty through the personal and professional networks of our project team members who are experts on the intervention and who are members of the faculty at the institutions we study. We focused on two institutions possessing introductory programming courses with existing equity gaps. The first was a large enrollment first-year engineering course with multiple instructors and sections. The second was a first-year engineering disciplinary course that covered much of the same content as the large enrollment first-year engineering course at the other institution but had only one section.

For the multi-section course, we used two strategies to address key faculty barriers to implementation of evidence-based practices: enhancing faculty motivation and changing the social norms of the department. First, we focused on the influential role of campus leaders, especially department chairs, for directly influencing faculty choices by sending messages about the need for change [33]. After the successful pilot implementation of the ecological belonging intervention (described above), we met with the department head and associate director of the program to share the results and get input on how to scale the effort. This short meeting focused on the problem (describing existing equity gaps from the data) as well as how our low-effort intervention offered a solution to this challenge. The department head provided an opportunity for a scheduled

discussion with all instructors of the course to share the same information and support discussion. This endorsement provided a subtle indication that administrators were supportive of our effort.

Second, we held a meeting to share a similar set of information with instructors in the course. This session focused on the need for the intervention, a brief summary of the intervention itself, a synthesis of prior research findings, and a description of next steps if instructors were willing to participate in the research study. A member of our research team who has implemented the intervention in one of her courses several times addressed questions regarding the intervention and its logistics. We recruited seven faculty members at this institution (4 treatment/3 control). For the single section institution, we directly recruited the participating faculty member (1 treatment).

As part of our recruitment procedures, we asked faculty members to fill out a pre-survey regarding their attitudes towards student development, their self-efficacy for supporting student success, their pedagogical choices, and their perceptions of barriers to implementing the intervention alongside its efficacy. Six engineering faculty completed the survey, all of whom were willing to implement the intervention in their course. Unfortunately, the lack of response from uninterested faculty prevents us from characterizing the differences between this population and those willing to implement the intervention. These differences remain a subject of future research. Due to the small sample size ($n = 6$) tests of statistical significance were considered inappropriate and no inferences regarding differences within the respondent population by way of teaching experience, academic rank, or other demographic or experiential factors could be performed. Of the respondents, many (83.3%) always felt a personal responsibility for helping struggling students succeed. Furthermore, many respondents were always or often willing to take time to understand students' challenges (100%), provide additional resources to them (100%), give them additional feedback on their work (83%), and adjust teaching methods to better meet student needs (100%). However, faculty also collectively indicated that sometimes there was nothing more they could do for their students (50%), and that sometimes or often they felt students were underprepared (100%), or that students should work harder in the course (97%). This data suggests that faculty maintain a nuanced perspective of student development and achievement, in which both parties have a large degree of agency, and responsibility, for outcomes associated with the course.

All respondents disagreed or strongly disagreed that students had a certain amount of intelligence, and they could not do much to change it. Similarly, almost all faculty members (83%) disagreed or strongly disagreed with the statement that intelligence is something that one cannot change very much. These response patterns indicate this faculty sample has a growth mindset for student development. Faculty members were also universally very or extremely willing to include activities in class that increase belonging for all students, for BLI and women students, and that would reduce equity gaps between student groups. However, faculty were collectively less willing to incorporate something new in their class, given the constraints of their curriculum (83% very willing, 17% slightly willing), to give up time for course content in exchange for an activity that enhances learning (83% very willing, 17% moderately willing), and to give up time for course

content in exchange for an activity that closes equity gaps (67% very willing, 33% moderately willing).

Faculty members reported a high degree of self-efficacy related to the intervention tasks. All respondents agreed or strongly agreed that they felt prepared to engage in class discussions on topics related to race, ethnicity, or gender; stop class to address emergent issues of student belonging; use student feedback to make content changes; conduct an educational activity to enhance student belonging; deviate from planned content to discuss current topics affecting students' lives; and be genuine with their students. Similarly, only 17% of respondents disagreed or strongly disagreed that they felt prepared to use student feedback to make policy changes, or help students learn to work inclusively during group projects. In sum, faculty respondents exhibited very high degrees of self-efficacy regarding the particulars of intervention, and of contributing to the transformation of their class culture.

The most frequent write-in concerns about the intervention focused on the amount of preparation and class time that it would require, alongside the difficulty of working the intervention into an already overburdened syllabus. Several less common concerns included a lack of self-efficacy on the part of faculty members for performing the intervention. Some faculty who considered themselves financially and educationally privileged and who had not experienced deep academic struggle questioned whether they could authentically empathize with and adequately respond to student academic struggle, or if their attempts to do so would be seen as disingenuous.

Collectively, these data indicate that faculty valued the interventions goals and generally felt able to implement the core activities associated with the intervention. However, fitting this effort into available class time was the largest challenge cited by faculty members in both the close and open-ended responses. Future efforts to institutionalize this intervention as a part of, rather than in an addition to, the curriculum may address this concern. There may also be opportunities to tailor the recruitment strategy to emphasize that the time investment in this effort has significant positive outcomes not only for students but also for the instructor-student relationship.

Regarding faculty training, prior to the start of the semester we developed a hybrid set of instructional materials. Two asynchronous videos were shared, and instructors were asked to watch them before a virtual synchronous session. The first video lasted roughly 25 minutes and focused on the theory of how the intervention works and the second video of roughly 10 minutes focused on the details of how to adapt and implement the intervention. The two hour-long synchronous session addressed common concerns and challenges of implementation through a set of scenarios and group discussion. Finally, all intervention instructors were given a customized packet with a calendar of actions specific to their teaching days and times, all relevant slides for the intervention, a lesson plan for the timing and details on implementation, and a list of supplies needed for the intervention.

In all these efforts, we focused on making the intervention easy to implement (low effort/high self-efficacy) to reduce cost value and improve instructor motivation. We offered an incentive for instructors to participate in the effort (\$500 for implementing instructors and \$250 for business-as-usual instructors). This incentive acknowledged the effort faculty would make in providing course rosters, advertising the pre- and post-survey to students, sharing all grade data with the research team, participating in surveys and interviews we engage in with instructors, and, for intervention instructors, participating in the training and implementing the intervention in the first week of classes.

Current and Future Work

Having trained our first group of faculty and worked during the last year to further develop, revise, and strengthen the validation argument for our surveys, and test our theory of action, we are poised to engage in a more robust test of the intervention [RQ2-3] at the conclusion of the 2022-2023 academic year. We are also continuing to contextualize the intervention for new classroom environments [RQ1], and recently conducted several focus groups of undergraduates in a first semester, first-year engineering course where much struggle was reported regarding teaming and adjustment to college. We will test the intervention in this new context during the third year of the grant, and with the continuation of the intervention another course at this institution, will examine the effects of multiple intervention doses upon BLI students (i.e., receiving the intervention multiple times across semesters related to different aspects of struggle contextualized in courses versus at only one point in time). This approach will further assist us in refining and testing our theory of action [RQ2-3]. In addition, during the third year of the grant we plan to deliver the intervention in at least one second-year engineering disciplinary course that exhibits significant equity gaps in achievement.

As we continue to scale the intervention into new engineering classroom environments, our efforts to address RQs 4-7 will continue. In the third year we will refine our faculty onboarding and training processes, and we plan to hold at least two additional training sessions for faculty who implement the intervention. We are currently in the process of interviewing our first group of faculty implementers and will use the analysis of this data to refine our onboarding strategies [RQ4] and better understand instructor beliefs and mindsets related to onboarding [RQ5], implementation [RQ6], and efficacy for continued implementation and change [RQ7]. To assist us in this effort, we have developed and employed a pre-/post-survey for faculty that assess instructor mindsets and beliefs about student success, which we are currently testing with our initial group of implementing faculty.

Other efforts to address RQs 2 and 3 continue. The quantitative validation of novel constructs employed in our student surveys are nearing conclusion, and we plan to publish a journal article next year based on our work in this area to date. The goal of this work is to make sure the scale items cohere as a scale, differentiate adequately from other motivational constructs, and do not

show bias/mismeasurement by race/ethnicity, gender, first-generation status, or low-income status. Within this next year we will also begin our structural equation modeling analysis to test our theories of how the constructs relate to one another and to student midterm behaviors and outcomes, and how our intervention changes student motivations and longer-term outcomes (e.g., retention at university, within engineering, and movement across engineering majors). In addition, our findings focusing on the results of the intervention that was implemented during the first year of the grant have been presented in a national conference [31] and a journal article is forthcoming.

We are also studying RQs 2 and 3 with a comprehensive, longitudinal set of individual interviews with students. As of this date, we have interviewed the initial cohort of students whose classrooms were part of our intervention during year one of the grant (treatment/control Spring 2022) three times and are poised to interview them for the fourth time (Fall 2023) as they enter their third college year and are fully embedded into their engineering disciplines. We have also conducted initial interviews with a second cohort of students whose classrooms were part of our intervention during Spring 2023 and will interview this group for the second time as they transition into their majors in Fall 2023. This work will allow us to understand not only how various doses of the intervention relate to the student experience but also how they relate to career goals, aspirations, and early career trajectories. Furthermore, we are working to investigate how and where students at the intersection of race/ethnicity and gender diverge in their experiences, identity development, and meaning-making. To date we have one conference publication [34] based on this data and another one in development. We are using interpretive phenomenological analysis [35] to analyze our qualitative data. This method focuses on understanding the “lived experience” of the participants’, specifically their first- (i.e., descriptions of tangible events) and second-order (i.e. socio-emotional reactions) experiences. We plan to use this extensive set of interview data and leverage it fully with the quantitative data from our student surveys within a mixed-methods design using a concurrent partially mixed methods approach [36]. These data and our approach to them will provide a richer and more comprehensive understanding of the student experiences and the engineering culture than would have been possible otherwise [37].

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